

**FRAMEWORK DOCUMENT for RESIDENTIAL FURNACES AND BOILERS
ENERGY CONSERVATION STANDARDS RULEMAKING**

Draft for Public Comment

**U.S. Department of Energy
Office of Building Research and Standards
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1. INTRODUCTION

The purpose of this document is to describe the procedural and analytical approaches the Department of Energy (hereafter called the Department or DOE) anticipates using to evaluate whether updated standards should be developed that are more stringent than existing standards for residential furnaces and boilers. As described in more detail below, the procedure for developing updated energy conservation standards entails several rounds of analysis and multiple consultations with stakeholders. This document is intended to inform and facilitate stakeholders' involvement in the rulemaking process. Section 1 provides an overview of the process. Sections 2 through 16 discuss analyses to be done. Information regarding the furnace and boiler standards rulemaking will be maintained on the DOE website at http://www.eren.doe.gov/buildings/codes_standards

Figure 1 shows a time line for establishing and updating standards for residential furnaces and boilers, starting with National Appliance Energy Conservation Act of 1987 (NAECA).

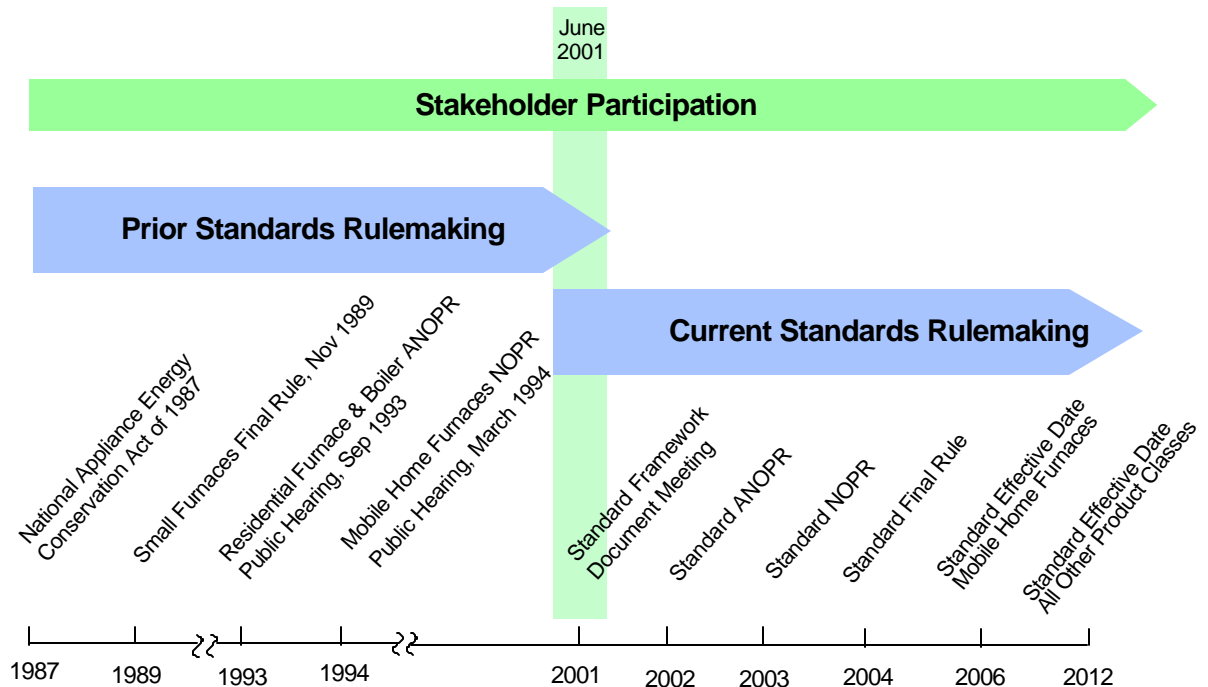


Figure 1. Principal procedural steps in the residential furnace and boiler standards setting process

In addition to the general discussion presented within its main text, this document contains comment boxes, like this one, that address issues specific to the application of the analytical framework to the residential furnaces and boilers rule. These boxes follow a generic description for each component of a typical energy efficiency standard rulemaking, and include a discussion of the key issues, the perspectives of the Department on these issues, and a request for additional stakeholder input.

Section 321(23) of Energy Policy and Conservation Act (EPCA) defines a furnace as follows: “the term ‘furnace’ means a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which

- (A) is designed to be the principal heating source for the living space of a residence;
- (B) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;
- (C) is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and
- (D) has a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.”

Section 325(f)(1)(B) of EPCA required the Department to publish a final rule by Jan 1, 1989, to

establish an efficiency standard for small furnaces (other than mobile home furnaces) having an input of less than 45,000 Btu/hr and manufactured on or after January 1, 1992. Section 325(f)(3)(A) of EPCA required the Department to publish a final rule by Jan 1, 1992, to determine if the statutorily established efficiency standard for mobile home furnaces (75% AFUE) should be amended. It also required that such rule must provide that any amendment to this standard level shall apply to mobile home furnaces manufactured on or after January 1, 1994. Based on section 325(f)(3)(B) of EPCA, the Department was also required to publish a final rule by January 1, 1994, to determine if the established efficiency standards for all furnaces (including mobile home furnaces) should be amended. It also required that such rule must provide that any amendment to this standard level shall apply to all furnaces (including mobile home furnaces) manufactured on or after January 1, 2002.

In light of the EPCA provisions which stipulate a shorter time frame and an extra review for mobile home furnaces, should the effective date of standards be different for mobile home furnaces than for the rest of the residential furnaces and boilers? Should this extra review be waived? If so, should the effective date for mobile home furnaces be shorter?

1.1 STAKEHOLDER PARTICIPATION

As also indicated by Figure 1, the Department considers stakeholder participation a very important part of the process for setting energy conservation standards. The Department actively encourages the participation and interaction of all stakeholders at all stages of the process. Early and frequent interactions among stakeholders provide a balanced discussion on critical information required to conduct the analysis to support any standards.

Stakeholders include manufacturers and consumers of furnaces and boilers, energy efficiency and environmental advocates, state agencies, federal agencies and other groups or individuals with an interest in the standards.

The energy conservation standards are developed through the rulemaking process, which involves formal public notifications that are common to the Department's rulemaking activities. For the furnace and boiler energy conservation standards rulemaking, the Department will employ the rulemaking procedures set forth in Part B of Title III of EPCA and in Appendix A to Subpart C of 10 Code of Federal Regulations (CFR) 430, "Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products" (the Process Rule), (61 FR 36981, July 15, 1996).

In an energy conservation standards rulemaking, the first of the rulemaking notices is an Advance Notice of Proposed Rulemaking (ANOPR), which is designed to facilitate extensive and early public participation and to select candidate standard levels for further analyses. The ANOPR is followed by the publication of a Notice of Proposed Rulemaking (NOPR) which will propose energy conservation standards. The completion of the rulemaking process is a Notice of Final Rulemaking which places the energy conservation standards in the Code of Federal Regulations.

The process provides numerous opportunities for stakeholder involvement. Specifically, the

Department intends to request public comments on the ANOPR, with a 75-day public comment period and at least one public hearing or workshop, and public comments on the NOPR, with a 75-day public comment period and at least one public hearing or workshop. These activities will be summarized and published in rulemaking notices that appear in the *Federal Register* and on the Department's website. Technical Support Documents (TSD) also will be prepared in conjunction with the notices and distributed for stakeholder review and comment in conjunction with publication of those notices.

In addition, the Department will elicit stakeholder participation prior to these notices and during analyses prepared in support of the notices. The first of these opportunities will be the framework meeting to discuss the information contained in this document, and the Department will also seek written comments on this document.

The formal rulemaking process for development of energy conservation standards includes three notices: ANOPR (see Section 1.2 below), NOPR (see Section 1.3 below), and the Notice of Final Rulemaking (see Section 1.4 below). The activities that are relevant to the development of energy conservation standards for furnaces and boilers leading to each of these notices and the relationships among them are described below.

1.2 ADVANCE NOTICE OF PROPOSED RULEMAKING

As part of its initial rulemaking activities, the Department will identify the product design options or efficiency levels that will be analyzed in detail and those that can be eliminated from further consideration. This process includes a preliminary market and technology assessment (see Section 3) and a screening process (see Section 4). These activities include consultations with stakeholders and independent technical experts who can assist with identifying the key issues and design options or efficiency levels to be considered.

The technologically feasible design options or efficiency levels that are not eliminated in the screening process are considered further. The principal activities undertaken during this stage are: an engineering analysis (see Section 5), a life-cycle cost analysis (see Section 8), and national energy savings and net present value analyses (see Section 10).

The results of the analyses will be made available on the Department's website for review and the Department will consider comments on them. This review and comment process may result in revisions to the analyses. If appropriate, public workshops may be conducted to enhance the exchange of information and comments. This analytical process culminates with the selection of candidate standard levels, if any, that will be considered for the Proposed Rule. The candidate standard levels are contained in the ANOPR which DOE publishes in the *Federal Register*. The ANOPR specifies the candidate standard levels that are chosen for further analysis but does not propose a particular standard. The ANOPR also presents the results of the engineering analysis and the preliminary analyses of consumer life-cycle costs, national net present value, and national energy savings. The Department will also make available a TSD containing the details of all the analyses performed to this point.

Selection of candidate standard levels is based on costs and benefits of design options or efficiency levels. Design options or efficiency levels which have payback periods that exceed the average life of the product or which cause life-cycle cost increases relative to the base case

would generally not be selected as candidate standard levels.

The range of candidate standard levels will typically include:

- the most energy efficient level;
- the level with the lowest life-cycle cost;
- a level with a payback period of not more than 3 years; and
- candidate standard levels that incorporate noteworthy technologies or fill in large gaps between efficiency levels of other candidate standard levels.

After the publication of the ANOPR, there is a 75-day public comment period and at least one public hearing or workshop. On the basis of comments received, DOE may revise the analysis or the candidate standard levels. If major changes are required, stakeholders and technical experts will be given an opportunity to review the revised analyses.

1.3 NOTICE OF PROPOSED RULEMAKING

After the ANOPR, DOE will conduct further economic impact analyses of the candidate standard levels. These analyses may include refinements of the analyses done for the ANOPR and also will include: a consumer sub-group analysis (see Section 12), a manufacturer impact analysis (see Section 13), a utility impact analysis (see Section 14), an environmental analysis (see Section 15), and net national employment impacts (see Section 16).

The results of all the analyses will be made available on the Department's website for review and the Department will consider comments on them. This review and comment process may result in revisions to the analyses. If appropriate, public workshops may be conducted to enhance the exchange of information and comments. This analytical process culminates with the selection of proposed standard levels, if any, that will be presented in the NOPR. The NOPR, published in the *Federal Register*, will document the evaluation and selection of any proposed standards. For each product class, the Department also will identify the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible and, if the proposed standards would not achieve these levels, the Department will identify the reasons for proposing different standards. The NOPR also will present the results of all the analyses. The Department will also make available a TSD containing the details of all the analyses.

The Department considers many factors in selecting proposed standards. These factors include the selection policies established by statute and the many benefits, costs and impacts of the standards shown by the analyses. Additionally, the Department encourages stakeholders to develop joint recommendations for standard levels. If the Department receives a joint recommendation from a representative group of stakeholders, such a recommendation will be strongly considered in the decision process to select the proposed standard level.

The NOPR is followed by a 75-day public comment period that includes at least one public hearing or workshop; revisions to the analyses may result from the public comments. On the basis of the public comments, DOE reviews the proposed standard and impact analyses and makes modifications as necessary. If major changes to the analyses are required at this stage, stakeholders and experts will be given an opportunity to review the revised analyses.

1.4 NOTICE OF FINAL RULEMAKING

The final step in the rulemaking process would be the publication of a Notice of Final Rulemaking in the *Federal Register*. The Final Notice promulgates standard levels based on the record and explains the basis for the selection of those standards. It is accompanied by the final TSD.

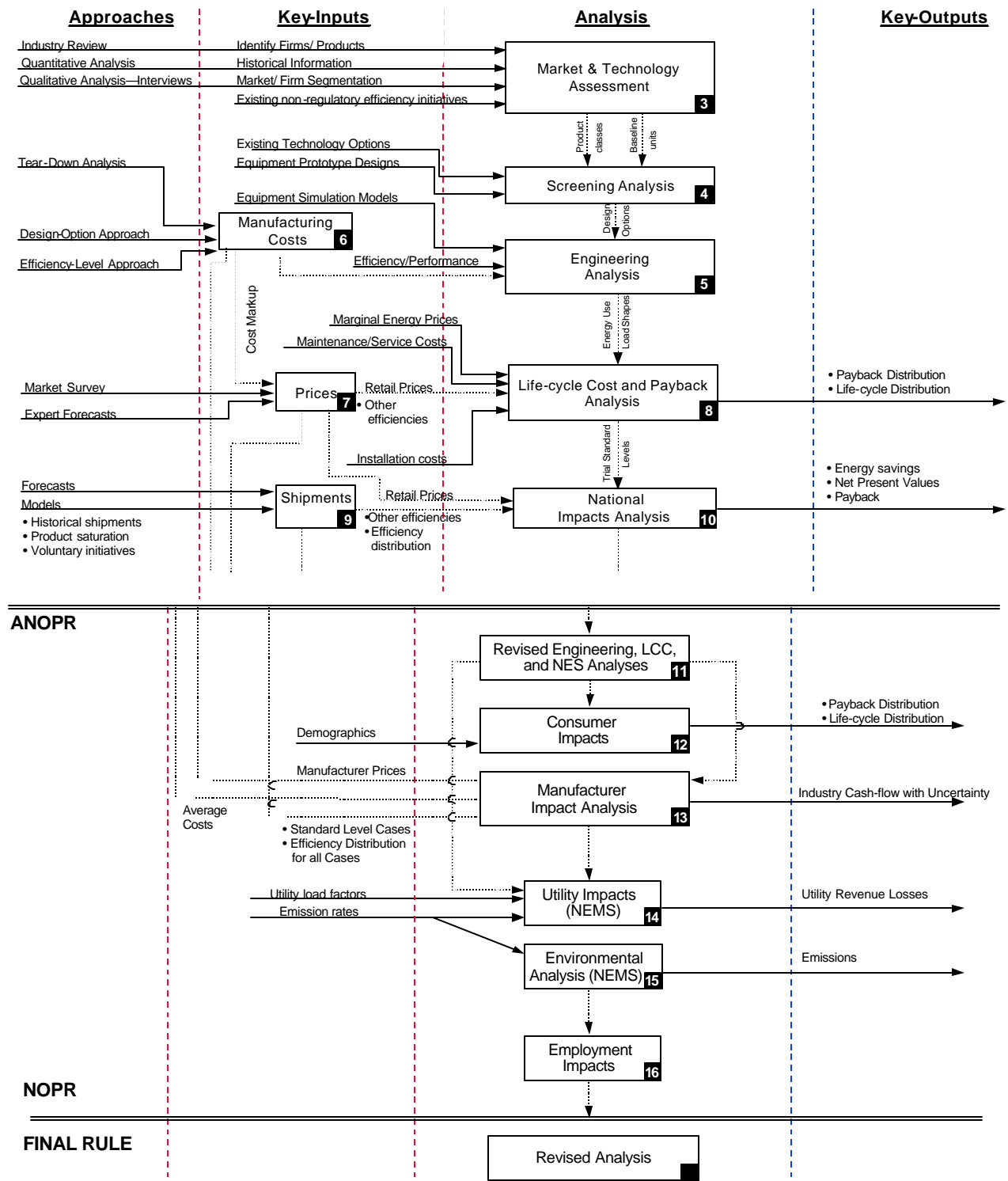
2. ANALYSES FOR RULEMAKING

This document provides a brief description of the analysis to determine the impacts of possible standards. It offers an overview of the analytic methodology and discusses the major components of the analysis. By considering the inter-relationship among these components, the consistency of approach throughout the analysis is ensured.

A diagram of the analytical framework is shown in Figure 2. This document will primarily emphasize those components of the methodology which are necessary for issuing an ANOPR.

The analytical components of the standards setting process are summarized in Figure 2. The focus of this figure is the center column, identified as “Analysis.” The columns labeled “Key Inputs” and “Key Outputs” are intended to indicate how the analyses fit into the rulemaking process, and how the analyses relate to each other. Key outputs are analytical results that feed directly into the standard-setting process. Dotted lines connecting analyses indicate types of information that feed from one analysis to another. Key inputs are the types of data and information that are required by the analyses. Some key inputs exist in public databases, some will be collected from stakeholders or others with special knowledge, and some of the key inputs will be developed by the project team to support the standards-setting process. Ultimately, the Department intends to select the furnace and boiler energy conservation standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. In the context of this process, economic justification includes consideration of the economic impacts on domestic furnace and boiler manufacturers and consumers of furnaces and boilers, national benefits including environmental, issues of consumer utility and impacts from any lessening of competition. Many of the analyses are aimed at answering questions about these aspects of economic justification.

Figure 2: Analytical Framework for Residential Furnaces and Boilers Rulemaking



3. MARKET AND TECHNOLOGY ASSESSMENT

3.1 MARKET ASSESSMENT

Prior to initiating a detailed impact analysis, the Department will develop information on the present and past industry structure and market characteristics of the product(s) concerned. It will be used throughout the standards development process, and at the outset, to determine product classes, to develop the baseline models, and to identify potential design options or efficiency levels for each of the product classes. This activity will assess the industry and products based on publicly available information. Issues to be addressed include the following: the manufacturer market shares and characteristics; current trends in the number of firms; the financial situation of individual manufacturers; the marketing channels (manufacturers, distributors, consumers) being used for different market segments; the existing non-regulatory efficiency improvement initiatives; and the current trends in product characteristics and retail markets.

The information collected above will serve as a resource for use throughout the rulemaking. For instance, market structure data will be particularly useful to conducting the competitive impacts analysis.

The Department has initiated a market assessment of the residential furnace and boiler industry. Once completed, collected information will be distributed to the stakeholders for comment.

The residential furnace and boiler market can be divided into segments that are almost completely independent according to the type of equipment, (e.g., central forced air furnaces, mobile home furnaces, hot-water and steam systems, cast iron boilers, and copper-finned tube boilers). The market can be further subdivided by the type of fuel used in the product. Currently the department is considering residential furnaces and boilers fired by the following fuels: natural gas, liquified petroleum gas (LPG), and fuel oil.

The Department plans to conduct interviews with manufacturers after the framework workshop. These interviews will be useful in developing an industry profile which can provide insights and information to help structure future analysis. The Department is also interested in developing profiles of individual manufacturers to gain a better understanding of the potential impacts of standards on both individual firms and particular categories of firms.

Interview participants will be requested to identify all confidential information provided in writing and orally. Approximately two weeks following the interview, an interview summary will be provided to give participants the opportunity to confirm the accuracy and protect the confidentiality of all collected information. All the information transmitted will be considered, when appropriate, in the Department's decision-making process. However, confidential information will not be made available for the public record.

Are there elements not mentioned in the above market characterization which should be incorporated into this document?

3.2 TECHNOLOGY ASSESSMENT

Information about existing and past technology options and prototype designs will typically be used as input to determine what technologies manufacturers could utilize to attain higher energy efficiency levels. In consultation with the stakeholders, the Department intends to develop a list of technologies that can and should be considered in the analysis. Initially, the list will encompass all technologies considered to be technologically feasible and it will also serve to establish the maximum technologically feasible design.

The Department has initiated a technology assessment for residential furnaces and boilers. The Department is collecting information on technologies that improve either the efficiency of fuel use or of electricity use. The technologies include those that can improve the overall heat transfer, the fan and motor efficiency, the combustion process, or the controls.

Are there specific technologies that should or should not be considered for residential furnaces and boilers?

3.3 PRODUCT CLASSES

Products may be separated into product classes if their capacity or other performance-related features or attributes, including those that provide utility to the user, inherently affect efficiency and justify the establishment of a different energy conservation standard, or possible exemption from energy conservation standards, for products with that feature or attribute. Some of the features or attributes that might justify the establishment of product classes for residential furnaces and boilers may include the type of energy used, or the capacity. The Department often defines product classes using information obtained in discussions with stakeholders and intends to do so as part of this process. The Department seeks discussion on whether the following features or attributes affect residential furnace and boiler efficiency and warrant separate product classes, and whether other characteristics not outlined below should be considered for defining separate product classes for these products because they affect efficiency and should be the basis for separate energy conservation standards or exemptions.

EPCA Section 321 (23) states that a “furnace” includes forced-air and gravity central furnaces, and low pressure steam and hot water boilers and it must have a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

There are two possible ways of classifying furnaces— based on the energy source (gas or oil) and the installation location. Based on the installation location, the furnace may be classified

as weatherized (i.e., located outdoor), or non-weatherized. Non-weatherized furnaces are rated as if they were isolated from the conditioned space. Such a system is called an isolated combustion system (ICS). In the ICS, the combustion and dilution air are drawn from the outdoors. It differs from the “indoors” rating applied for boilers classes only, which assumes that the combustion and dilution air are drawn from the conditioned space. “Outdoor” rating assumes that the unit is located outdoors.

In the ANOPR (58 Fed. Reg. 47326) for residential furnaces and boilers issued on September 8, 1993, DOE proposed to consider the following product classes:

- Gas furnaces
 - Weatherized
 - Non-weatherized
- Oil furnaces
 - Weatherized
 - Non-weatherized
- Mobile home furnaces
 - Gas
 - Oil
- Hot-water boilers
 - Gas
 - Oil
- Steam boilers
 - Gas
 - Oil
- Combination space/water heating appliance
 - Gas
 - Oil

Gas furnaces are the predominant type of furnaces in today's market and are found in both weatherized and non-weatherized categories. Mobile home furnaces fall entirely in the non-weatherized category. Boilers are rated as “indoors” or “outdoors”.

There is currently no DOE test procedure for combination appliances, which provide both space heating and domestic hot water. An American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) test procedure for these products is currently under development. Therefore combination appliances are not being considered for the current rulemaking.

Are there any other performance-related features that may warrant creating separate classes for the products that possess them? If so, what factors, including preserving the utility of the features to owners, should we consider when deciding whether to establish the new classes? Please comment as to whether the Department should pursue establishing additional classes.

Are there some product classes with such low volumes of annual shipments that the department should not undertake analysis to determine if the efficiency standards should be

upgraded? Are there some product classes that should be combined or merged?

3.4 BASELINE UNITS

Defining a baseline unit is the starting point for the screening analysis. For each product class, the baseline unit represents a model with the minimum allowable energy efficiency as specified in NAECA 1987 and subsequent amendments for small furnaces.

One of the key parameters required for establishing the baseline model is its efficiency. In this rulemaking, the Department intends to use the following NAECA 1987 minimum efficiency levels as the primary baseline efficiency: a minimum Annual Fuel Utilization Efficiency (AFUE) of 78% for gas- and oil-fired central furnaces, 75% for mobile home furnaces, 75% for gas steam boilers, and 80% for all other boilers.

If additional product classes are established, the Department will apply the appropriate existing standard as the baseline efficiency for that class.

If more detailed approaches, such as a design option approach, are selected for conducting the engineering analysis, manufacturers may be requested to supply details on the technologies that they utilize in their baseline or minimum efficiency models. This information will assist the Department in establishing the individual technologies that can be employed to increase the efficiency of the product.

Which baseline efficiency levels are most appropriate for this rulemaking?

What equipment capacity should be used in the analysis as the representative capacity for each product class? Should this value be the same for central furnaces, mobile home furnaces, hot water boilers, and steam boilers, or are unique values warranted? If so, what should they be?

4. SCREENING ANALYSIS

The screening analysis consists of reviewing and selecting the design options for further analysis.

An initial list of design options will be developed from the technologies identified during the technology assessment. After the development of this initial list, the Department will review each design option in consultation with stakeholders to determine if it is practicable to manufacture, install and service; would adversely impact product utility or product availability; or would have adverse impacts on health and safety. All design options will be carefully screened to meet these criteria. Only the design options not eliminated during the screening process will be considered further in the engineering analysis.

Compiling a list of design options will provide a better understanding of which technologies can potentially be utilized by manufacturers to improve the equipment efficiency. Knowing the technologies that are available to manufacturers will also help the Department determine the maximum technologically feasible efficiency levels.

In developing a list of design options, the Department's primary consideration is how a technology will impact the primary-fuel based efficiency of the equipment as expressed by its AFUE. Another consideration is how it will affect the electricity use determined by such indices as the annual electrical consumption (E_{AE}), which is separately calculated from the DOE Test Procedure for residential furnaces/boilers.

An initial list of technologies includes:

- (A) Improved Heat Exchanger Effectiveness
- (B) Electronic Ignition
- (C) Increased Fan Efficiency (Air Circulating and Combustion Air Fans)
- (D) Increased Motor Efficiency (Air Circulating and Combustion Air Fans)
- (E) Induced or Forced Draft
- (F) Infrared Burner
- (G) Two-Stage Modulation
- (H) Continuous Modulation
- (I) Condensing Flue Gases
- (J) Pulse Combustion (Gas and Oil)
- (K) Burner Box or Flue Damper
- (L) Stack Damper
- (M) Improved or Increased Insulation
- (N) Thermophotovoltaic Control System
- (O) Gas Driven Heat Pumps
- (P) Alternative Fan Motor Speed Control

- (Q) Electrohydrodynamic Enhancement of Heat Exchangers
- (R) Delayed Action Oil Pump Solenoid Valve
- (S) Flue Gas Recirculation
- (T) Atomized Oil Burner
- (U) Interrupted Ignition Oil Burner

Are there specific technologies that should or should not be considered for residential furnaces and boilers?

5. ENGINEERING ANALYSIS

The engineering analysis consists of estimating the energy consumption and costs of furnaces and boilers at various levels of increased efficiency. This chapter discusses an overview of the engineering analysis (Section 5.1), two alternative approaches to estimating efficiency levels (Section 5.2), and one of the major cost estimation methods, namely tear-down analysis (Section 5.3). This chapter also discusses electricity consumption for residential furnaces and boilers (Section 5.4) and other regulatory impacts on the engineering analysis (Section 5.5).

5.1 ENGINEERING ANALYSIS OVERVIEW

The purpose of the engineering analysis is to evaluate the increased equipment efficiency levels and estimate the associated manufacturing costs. The baseline units and possible design options are identified in the screening analysis (see Section 4). The Department, in consultation with stakeholders, will use the most appropriate means that are available to determine the energy efficiency levels, possibly including an overall system approach or engineering modeling of the system. The analysis will also account for the ranges and uncertainties in the estimated energy performance and costs.

The engineering analysis involves estimating the possible efficiency increases based on the baseline units (described in Section 3.4). Once the baseline units are established, a cost-efficiency relationship will be developed. The cost-efficiency relationship requires data for two items: values for the descriptor(s) associated with considered efficiency levels and the cost estimates to achieve the increased efficiency.

The efficiency levels corresponding to various design option combinations will be determined from the information on products that are commercially available, data submitted by manufacturers and/or engineering calculations.

Cost estimates for the engineering analysis (which are also used for the manufacturer impact analysis, to be discussed in Section 6) will be obtained from detailed incremental manufacturer cost data, which include the cost of the equipment components, labor, purchased parts and material, shipping/packaging and investment. Estimates of the total cost to the consumer (to be discussed in Section 7) include the retail price of equipment and energy and the installation and maintenance costs. The Department will generate manufacturing cost estimates through the use of some combination of tear-down analysis, manufacturer supplied estimates, and direct estimates of retail prices.

In order to establish a relationship between cost and performance, several key decisions have to be made. The Department understands that a fundamental decision is whether to use the *design option* or *efficiency level approach* for determining efficiency levels to be studied, as discussed in Section 5.2. Another fundamental decision concerns selecting a cost estimation method for those efficiency levels, as discussed in Section 5.3. For example the Department

may consider the tear-down approach.

5.2 APPROACHES TO DETERMINING EFFICIENCY IMPROVEMENTS

There are two methods for identifying the opportunities for increasing energy efficiency: the design option approach (technology specific) and the efficiency level approach (mix of technologies at specific efficiency levels).

5.2.1 Design Option Approach

Under the design option approach, individual design options or combinations of design options are identified for increasing efficiency. Design option efficiency increases can either be based on manufacturer or component supplier estimates or can be estimated through the use of engineering computer simulation models. The incremental manufacturing costs of adding design options to a baseline model are then established. Individual design options or combinations of design options are added to the baseline model in order of ascending cost-effectiveness. The payback period is typically determined by taking the ratio of the change in total installed cost (compared to the baseline) to the reduced operating cost (again, compared to the baseline), as determined by the test procedure. The design options are then ranked, with lower payback designs added to the baseline first. Operating costs under the full range of field conditions are addressed later in the Life-Cycle Cost (LCC) Analysis.

The primary advantage of the design option approach is its ability to analyze individual technologies and to combine them in sequence. The approach is transparent in that the impact of any single technology on cost and efficiency can be explicitly established. An additional advantage is its ability to incorporate designs whose performance has been demonstrated in prototypes but not yet available in equipment currently on the market. Thus, maximum technologically feasible designs are more easily established in this approach than in the efficiency level approach.

Although individual technologies can be assessed under the design option approach, the procedure can be complex. If individual technologies (especially prototype designs) are combined in ways not typically utilized by manufacturers, attention must be paid to the overall system cost and efficiency. In order to determine a technology's impact on the system efficiency, a computer simulation model is typically employed. Since computer simulation models exhibit at least some level of inaccuracy, time and effort must be expended to validate a model's results under a variety of operating conditions. Simulation models may demand detailed input balanced by the need to protect manufacturers' and component suppliers' proprietary design strategies. Also, the equipment performance data at specified test conditions must be acquired in order to validate a model's performance.

The design option approach must be reconciled with the manufacturing impact analysis. The Department recognizes that the manufacturer cost information derived in a component-based analysis should reflect the variability in baseline units, design strategies and cost structures that can exist among manufacturers, in order to be most useful in the manufacturing impact analysis. Therefore, for the manufacturing impact analysis, the Department may need to derive

additional manufacturing cost estimates, using other approaches developed in consultation with stakeholders (see Section 6).

If the design option approach is used for the engineering analysis, methods will have to be established for determining efficiency increases. As stated above, this can be done either directly through stakeholder input or through the use of computer simulation models. There is at least one public domain computer model developed for the Gas Technology Institute (GTI) which could be used to determine equipment efficiency.

The Department seeks input from stakeholders as to how efficiency impacts could be determined under the design option approach. If computer simulation models are to be used, which specific model should be used by the Department?

5.2.2 Efficiency Level Approach

The efficiency level approach establishes a relationship between manufacturer cost and increased efficiency at predetermined efficiency levels. It has the initial advantage of being simple and straightforward. During the rulemaking process, manufacturers (typically through their trade associations) provide incremental manufacturer cost data for incremental increases in efficiency. Cost-efficiency curves can then be constructed directly from this data. Additionally, the efficiency level approach allows manufacturers the ability to supply detailed cost data without revealing unique and proprietary design strategies for achieving the increased efficiency levels.

However, the simplicity of the efficiency level approach is also its primary drawback. Namely, since technological details are not available, it is difficult to verify whether the costs being provided are comparable and accurately represent the specific efficiency level. In addition, prototypical designs become difficult to evaluate and maximum technologically feasible designs are then difficult to ascertain. For example, if two manufacturers choose markedly different designs with significantly different costs to attain the same efficiency level, taking an average of the costs may not accurately represent the situation. As a result, some stakeholders may prefer to supplement the engineering analysis with additional detail which needs to be derived from other sources in order to verify the accuracy of the data supplied through the efficiency level approach.

If the efficiency level approach is selected for conducting the engineering analysis, predetermined efficiency levels will be selected by the Department based on consultations with stakeholders. Efficiency levels will be based upon the AFUE for fuel efficiency and the E_{AE} for electricity use.

As discussed above, the efficiency level approach requires some verification of the data submitted. Other approaches, such as the design option method, can be conducted in parallel with the efficiency level approach used to verify the accuracy of its data.

The Department seeks input on what methods could be utilized to verify the data provided by manufacturers using the efficiency level approach. The Department also seeks comments on the appropriate ways to align the AFUE and E_{AE} levels.

5.3 APPROACHES TO DETERMINING COST ESTIMATES

The Department strongly prefers to use a single set of cost-efficiency estimates in its analysis, and to account for variability and uncertainty by using ranges, rather than analyzing competing scenarios. Stakeholders are welcome to submit their own estimates in the form of a public comment, but the Department intends to analyze the differences among independent estimates and to synthesize them into a range along with a most likely value. The cost estimates used should have the following characteristics:

- a level of transparency that permits validation by outside parties,
- a level of detail that permits outside parties to evaluate the design choices underlying the analysis,
- protection of sensitive or confidential information,
- a basis of generally accepted cost and performance estimation methodologies,
- an assessable level of statistical certainty, and
- availability by the scheduled deadline.

To the extent possible, the Department will seek the involvement of outside experts, and will include manufacturers and other stakeholders in the process.

Are there a particular cost estimating methodologies that are most appropriate for residential furnaces/boilers? What role will manufacturers or other stakeholders be willing to play in the development of cost estimates?

Tear-Down Analysis

The use of a component-based engineering analysis or tear-down analysis provides useful information including the identification of potential technological paths manufacturers could use to achieve increased equipment energy efficiency. Under tear-down analysis, “off-the-shelf” equipment commercially available on the market are purchased and physically analyzed, i.e.,

dismantled component-by-component to determine what technologies and designs manufacturers currently employ to increase energy efficiency. Independent costing methods along with manufacturer and component supplier data are then used to estimate the costs of the components.

The tear-down analysis will be drawing on readily available data (provided directly by individual manufacturers through a process approved by the trade organization). For the tear-down analysis to satisfy the data requirements, the Department anticipates it will be necessary to:

- 1) develop a consensus methodology with stakeholders' input,
- 2) work with the trade organization and individual manufacturers to select a statistically representative sample of products,
- 3) receive key design data from those manufacturers for the sample products,
- 4) undertake tear-downs and production cost analysis,
- 5) verify Department estimates with the individual manufacturers to whom they apply,
- 6) aggregate the results and present them to the trade organization for review, and
- 7) revise the analysis and present it to the stakeholders for review and comment.

The primary disadvantage of tear-down analysis is the time and effort required to analyze “off-the-shelf” equipment. Several models from a diverse range of manufacturers may have to be assessed in order to ensure that an accurate representation of technological paths for increasing efficiency are identified. In addition, since only the “off-the-shelf” equipment at hand is being analyzed, new combinations of existing technologies or prototypical designs may not be captured by the analysis, thus making it difficult to establish the maximum technologically feasible designs.

Tear-down analysis is a complementary methodology to both the design option and efficiency level approaches. It can serve as verification of costs collected for an efficiency level analysis or provide information on design options and costs for a design option analysis.

Several different residential furnace and boiler models will need to be evaluated in order to ensure that all representative technologies for increasing efficiency are identified.

What guidelines should the Department consider when selecting the number and types of models to be analyzed under tear-down analysis?

5.4 ELECTRICITY USE FOR RESIDENTIAL FURNACES AND BOILERS

Electricity consumption by fuel-fired residential furnaces and boilers is substantial and is not captured by the AFUE energy descriptor. The Department is considering ways in which the electricity consumption of fuel-fired residential furnaces and boilers could be improved.

The equipment efficiency descriptor, AFUE, is derived from a standard test procedure. The

test procedure does not provide an efficiency descriptor which includes the electricity used by the equipment. However, it provides a procedure to calculate the annual electricity use. Some equipment design options intended to improve AFUE can negatively impact electricity use. Conversely, some design options intended to improve electricity use, can negatively impact AFUE. The Department intends to assess the impact of design options on AFUE as well as on the electricity used by the equipment.

Current standards for residential furnaces and boilers are based on the AFUE only. What are the potential benefits and drawbacks of mandating a minimum fuel efficiency standard as well as an annual electricity consumption in this rulemaking?

A logical way to regulate the electricity use of fuel-fired residential furnaces and boilers would be to specify a maximum annual electrical consumption (E_{AE}) that would vary by the rated output of the equipment. The current DOE test procedure (10CFR430, Subpart B, Appendix N) provides a means to determine AFUE and also calculates E_{AE} . The Gas Appliance Manufacturers' Association (GAMA) and the California Energy Commission (CEC) both list E_{AE} in their directories.

The Department is seeking comment on whether to regulate electricity use by fuel-fired residential furnaces and boilers and if the proposed method is appropriate.

5.5 OTHER REGULATORY CHANGES AFFECTING THE ENGINEERING ANALYSIS

While conducting the engineering analysis, the Department will attempt to identify “outside” regulations and issues that could impact the engineering analysis, such as building codes, Environmental Protection agency (EPA) regulations (emission standards), and plumbing/sewage system restriction issues.

Are there any additional “outside” issues that stakeholders are aware of that should be considered by the Department in its analysis of residential furnaces and boilers?

6. MANUFACTURING COSTS

Manufacturing costs are needed for the engineering analysis as well as for the manufacturer impact analysis and are used as one means of determining retail prices. This section discusses three considerations of manufacturing costs important to the manufacturer impact analysis, specifically characterization of uncertainty (Section 6.1), variability among manufacturers' costs (Section 6.2), and treatment of proprietary designs (Section 6.3).

The Department intends to ask manufacturers to participate in the development of the cost estimates. The Department intends to develop its own cost estimates in cooperation with the manufacturers. The Department recognizes that any cost estimates developed by using the design option approach may need to be revised for the manufacturer impact analysis in order to account for different design strategies.

The Department welcomes suggestions and comments concerning the development of manufacturing cost information.

6.1 CHARACTERIZING UNCERTAINTY

DOE intends to establish a range of costs around the average manufacturing cost of incorporating various design options (or achieving various efficiency levels).

The Department proposes that the cost estimation method be bounded by a range. For example, manufacturers could provide their most likely point estimate and a range describing the lowest and highest values they consider likely (for each design option or efficiency level). Those values could be used to construct either a triangular or bounded normal distribution for costs. Similar approaches were used during some recent rulemakings. (For example, the design-option approach was used during the residential water heater rulemaking and the efficiency-level approach during the residential clothes washer rulemaking.) The individual manufacturer submittals would be aggregated by using a spreadsheet model and summaries would be reported as percentile values. The entire cost distribution would then be used in the calculation of life-cycle costs.

The Department seeks comment on these approaches to quantifying the uncertainty in our manufacturing cost estimates.

6.2 VARIABILITY IN COSTS BETWEEN MANUFACTURERS

The Department is committed to assessing the differential impacts of standards on individual manufacturers. The detailed sub-group manufacturing impact analysis will entail calculating cash flows separately for each class of manufacturer defined. If appropriate, manufacturer impact analyses will be performed for individual firms.

Manufacturing costs submitted to DOE for appliance standard analyses have demonstrated a large variability. The Department prefers using cost data from all manufacturers. The company-specific cost information developed for the engineering analysis can also be used to perform analysis for each manufacturer or manufacturer subgroup.

The method to be used in assessing manufacturer impacts will be discussed during an analysis workshop to be held after publication of the ANOPR. The Department is considering use of the Government Regulatory Impact Model (GRIM), which has been used in the rulemaking for several other products.

The Department seeks comment on the approach of grouping the manufacturers.

6.3 PROPRIETARY DESIGNS

The Department will consider in its analysis all design options that are commercially available or present in a working prototype, including proprietary designs. Proprietary designs will be fully considered in the Department's engineering and economic analyses.

The Department is sensitive to manufacturer concerns regarding proprietary designs and will ensure that provisions are made to maintain the confidentiality of any proprietary data submitted by manufacturers. This information will provide input to the competitive impacts assessment and other economic analyses.

Are there proprietary designs which the Department should consider for residential furnaces and boilers? If so, what types of approaches should be used to acquire the cost data necessary for evaluating these designs?

7. PRICES

How standards-related manufacturing costs are passed-through from manufacturers to consumers has an impact on both consumers and manufacturers. The consumer and manufacturer impact analyses are linked. For this reason, retail prices used for the life-cycle cost analysis need to be reconciled with manufacturer costs developed in the engineering analysis.

7.1 RETAIL PRICES

At the pre-ANOPR stage, a consumer life-cycle cost analysis, based on average retail prices, is used to perform an initial selection of potential standards levels. Retail prices are needed for the base case, and for all efficiency levels to be considered. Several approaches are possible to obtain these retail prices. Potential approaches include: 1) using a survey of existing prices on the market; 2) surveying manufacturers and other market experts to predict consumer willingness to pay higher prices; 3) applying various mark-ups to variable manufacturing costs.

The Department is considering using all of the approaches described above to generate estimates of future prices and to conduct uncertainty analysis of the range generated, and will submit results to stakeholders for review.

Which of the above approaches are most appropriate for this rule? Which are the most appropriate data sources to use? Are there any factors to consider that may distort the results? The Department welcomes suggestions and comments concerning collection of estimates of future retail prices.

Additionally, the Department seeks input regarding the following specific issues:

How should the Department collect accurate equipment costs and prices for residential equipment that is not usually sold as a retail commodity? Should the Department handle equipment pricing differently for new construction vs. retrofit since the volume purchasing for new construction may result in lower prices to the consumers?

7.2 MANUFACTURER PRICES

Manufacturer prices are used during the industry cash flow phase of the manufacturer impact analysis (section 13). These can be estimated by using the same techniques as retail prices, but they can also draw directly on information provided by manufacturers or distributors or tracked by organizations such as the U.S. Census Bureau or private market reports.

The Department welcomes suggestions and comments concerning estimates of current and future manufacturer prices.

7.3 INSTALLATION AND MAINTENANCE COSTS

Installation and maintenance costs together with retail prices are used in the life-cycle cost analysis. These costs can be estimated using the same techniques used to develop retail prices. Installation and maintenance costs can also be derived directly from information provided by distributors or installers.

The Department welcomes suggestions and comments concerning estimates of current and future installation and maintenance costs.

8. LIFE-CYCLE COST AND PAYBACK ANALYSIS

The effect of standards on a purchaser of a product includes a change in the operating expense (which usually decreases) and a change in the purchase price (which usually increases). The net effect is analyzed by calculating the life-cycle cost using the engineering performance data for energy consumption and equipment retail prices. Inputs to the LCC calculation include the installed cost to the purchaser (purchase price plus installation cost), operating expenses (energy and maintenance costs), lifetime of the appliance, and a discount rate.

In the ANOPR stage, the life-cycle cost analysis will be conducted using typical values to reflect conditions in the field for appliance price and life, fuel costs, energy usage and discount rates. The detailed impact calculation, conducted after the ANOPR, will have a comprehensive assessment of impacts on subgroups of purchasers as described in Section 12.

In analyzing residential furnace and boiler life-cycle costs, there are two possible approaches the Department may take in estimating equipment energy consumption. One approach relies on conditional demand analysis estimates of heating loads while the other uses simulation-based modeling. Either approach can consider regional impacts due to climate and energy price on life-cycle cost.

Do stakeholders believe that regional variations in climate and energy price should be analyzed at this stage (the ANOPR stage) of the analysis or at a later stage (the NOPR stage)? The Department seeks input from stakeholders as to the reasonableness of each of the above approaches (i.e., heating load estimation or simulation-based building analysis) for estimating the impacts of energy price and climate on life-cycle cost.

In the ANOPR stage, uncertainty analysis will be conducted on several key variables. During the post-ANOPR consumer analysis (Section 12), the Department will evaluate additional parameters identified as significant.

Based on results of the life-cycle cost analysis, DOE will select candidate standard levels for analysis. The range of candidate standard levels will typically include a combination of design options or efficiency levels with the lowest life-cycle cost, as well as other levels yet to be determined by the Department.

For residential furnaces and boilers, it will be necessary to determine input values for several variables. The following discusses some of these variables.

Retail Prices: The determination of prices is described in Section 7.

Annual Energy Use: As described above, the Department may choose to base operating and life-

cycle cost either on estimates of usage patterns, or on building energy simulations developed from data, in order to provide a reasonable estimate of the savings possible from more efficient equipment in addition to demonstrating the variability in life-cycle costs due to climatic conditions and energy price.

Fuel and Electricity Prices: Projections of future energy price trends for the life-cycle cost analysis will use high and low projections of national average residential energy prices by type. The most recent Energy Information Administration (EIA) Annual Energy Outlook will be used as the main source of projections for this uncertainty analysis. The Department is considering alternative methods of forecasting future energy prices including methods for determining the marginal energy prices.

Lifetime: Industry sources indicate that the approximate average life of residential furnaces is 17-18 years, while the typical life of residential boilers is 25 years. The Department is likely to use these as mean values with uncertainty based on stakeholder input.

Are these reasonable values for the lifetimes? What are reasonable ranges of values for the equipment lifetimes, and do they depend on operating conditions, applications and geography? Should the same range be used for all product classes?

Discount Rate: The calculation of consumer life-cycle costs requires the use of an appropriate discount rate. The discount rate used in such calculations is intended to approximate the time-value of money of those who would pay the additional equipment prices resulting from a proposed standard and who would also, presumably, benefit from the resulting savings in energy expenses. Consequently, the most appropriate discount rate depends on the characteristics of the parties affected by a proposed standard. Currently the Department anticipates performing separate analyses using a discount rate of approximately 6%, with a range from 0% to 18%, consistent with the discount rates used in a recent residential central Air Conditioners and Heat Pumps rulemaking analysis. The Department will consider any information that provides evidence of purchasers' actual financing or opportunity costs related to residential furnaces and boilers and may use a distribution of discount rates, if appropriate.

Maintenance, Service, and Installation Costs: The Department will consider expected changes to maintenance, service, and installation costs for residential furnaces and boilers where applicable.

For other energy-using products (e.g., water heaters or central air conditioners), the Department has prepared spreadsheet models for calculating LCC considering uncertainty and ranges in input variables. Although these models are specific to each product, their general structure can be applied to residential furnaces and boilers. The past models will be presented at the Workshop to demonstrate basic concepts pertaining to the LCC analysis.

9. SHIPMENTS

9.1 BASE CASE SHIPMENTS FORECAST

The Department intends to develop a base case forecast of equipment shipments in the absence of more stringent standards. This forecast will include a distribution of shipments by efficiency level and will require an assessment of the impacts of past and existing non-regulatory efforts by manufacturers, utilities and other stakeholders. DOE intends to seek information on the actual impacts of such initiatives to date, but may also consider any information regarding the possible impacts that existing initiatives might have in the future. Such information could include a demonstration of the steps that manufacturers, distribution channels, utilities or others will take to realize such voluntary efficiency improvements.

What existing non-regulatory initiatives should DOE consider? What other approaches should the Department consider to establish the base case shipments forecast?

The base case shipments forecast will be used as input to three subsequent analyses: the National Impacts Analysis (Section 10); Industry Cash Flow Analysis (Section 13); and the Manufacturer Sub-Group Analysis (Section 13).

9.2 STANDARDS CASES SHIPMENTS FORECASTS

To perform the National Impacts Analysis, a forecast of shipment weighted efficiency of new equipment is estimated annually to the year 2030. To assess the average impact on the affected consumer population and the distribution of these impacts on consumer sub-groups, a forecast of equipment shipments by efficiency level is needed for the year a new standard would come into effect. To assess the industry cash flow, a forecast of annual equipment shipments is needed.

For all candidate standard levels, DOE is considering the use of two approaches to conduct the required shipment forecasts: 1) a time series regression model to derive shipments based on an analysis of key market drivers for the particular product; and 2) an accounting model to consider additional variables (e.g., retirement functions, price elasticities).

What other approaches should the Department consider to establish the standard cases shipments forecast? What are the best information sources for past shipment data by efficiency level?

The appliance standards analysis recently conducted for residential central air conditioners and heat pumps serves as an example of what methods can be employed to forecast the base case shipments. Of the proposed forecasts for base case shipments, several are based on time series data. Although time series models tend to give accurate fits to historical shipment trends, they cannot explicitly account for changes in the number of households, changes in the percent of households owning the appliance, fluctuations in retail price, or changes in operating expense.

Another method used previously, termed the *accounting model*, based on the accounting of new building construction and historical rates of ownership (saturation rates), is also proposed here. Primary drawbacks of this method include: 1) saturations of units in new and stock buildings must be forecasted, 2) building construction must also be forecasted, although the *Annual Energy Outlook (AEO)* and other sources do provide readily available forecasts, and 3) retirement of units must be based upon assumptions regarding lifetimes. However, this simplified method has the advantage of separately accounting for units installed in new construction and existing buildings. More importantly, product saturation rates can be expressed as a function of consumer price and operating cost to capture their impact on future shipments. In expressing saturation rates in this manner, consumer price and operating cost elasticities can be developed to calibrate forecasts to historical shipments.

Since the *accounting model* can account for changes in consumer price and operating cost and for possible fuel switching, the Department is considering the use of this approach, adapted to the residential furnaces and boilers market, to estimate base case shipments forecasts.

What alternate approaches should we consider for forecasting shipments?

10. NATIONAL IMPACTS ANALYSIS

In Section 8, the life-cycle cost and pay back for individual consumers are estimated. In this section, a preliminary assessment of the aggregate impacts at the national level is conducted. Measures of impact to be reported include the net present value of total consumer life-cycle costs, national energy savings and national employment.

10.1 INPUTS TO FORECASTS

Analyzing impacts of Federal energy-efficiency standards requires a comparison of projected U.S. energy consumption with and without new (more stringent) standards. The cases without new standards are referred to as base case projections. The forecasts contain projections of unit energy consumption of new equipment, annual equipment shipments and the price of purchased equipment. The derivations of the base case shipments forecast are described in Section 9.1 and standards case shipments forecasts are discussed in Section 9.2. Approaches to determining retail prices are described in Section 7.1.

The base case shipments forecast developed under Section 9.1 would incorporate the likely effects of market forces and of any non-regulatory initiatives.

10.2 CALCULATION OF ENERGY SAVINGS

The Department intends to calculate the national energy consumption for each year beginning with the expected compliance date of the standards for each analysis scenario. National energy consumption by fuel type will be calculated for the base case and for each candidate standard level. This calculation may be done by one or more alternative approaches, including: 1) use of a simple spreadsheet to multiply annual shipment forecasts by unit energy savings; or 2) use of the Energy Information Administration's National Energy Modeling System (NEMS).

In response to requests from some stakeholders for a simple, transparent model, LBNL has developed for DOE the National Energy Savings (NES) spreadsheets. NES provides a credible stand-alone forecast of national energy savings and net present value for residential furnaces and boilers.

The Department has prepared spreadsheet models for other products to forecast energy savings and to demonstrate how the growth in efficiency can be accounted for over time. Although these models are specific to each product, their general structure can also be applied to residential furnaces and boilers.

10.3 NATIONAL NET PRESENT VALUE

The national net present value of the candidate standards levels is calculated in conjunction with the national energy consumption. Annual energy expenditures are calculated from annual energy consumption by incorporating forecasted energy prices. The shipment and energy efficiency distribution forecasts from Sections 9.1 and 9.2 are used. Annual equipment expenditures are calculated from the price per unit times the forecasted shipments. The difference between a base case and a standards case scenario represents the national energy bill savings and the increased equipment expenditures in dollars. The difference each year between energy bill savings and increased equipment expenditures represents the net savings (if positive) or net costs (if negative). These annual values are discounted to the present and aggregated to obtain the net present value result.

11. REVISED ENGINEERING, LCC, AND NES ANALYSIS

Based on consideration of the comments received for the ANOPR, DOE will make the necessary changes to the analysis and candidate standards levels. If major changes are required at this stage, stakeholders will be given an opportunity to review them.

12. CONSUMER IMPACTS

The analysis of consumer impacts will include: estimated life-cycle cost impacts on consumers based on the national average energy prices and energy usage; assessments of life-cycle cost impacts on subgroups of consumers based on major regional differences in usage or energy prices and significant variations in installation costs or performance; sensitivity analyses using high and low discount rates and high and low energy price forecasts; consideration of changes to product utility and other impacts of likely concern to all (or some) consumers, based to the extent practicable on direct input from consumers; and consideration of the increased first cost to consumers and the time required for energy cost savings to pay back these first costs.

12.1 CONSUMER SUB-GROUP ANALYSIS

The Department will analyze LCC for specific subsets of the population that are likely, for one reason or another, to be impacted disproportionately by new standards.

What, if any, consumer issues are associated with higher efficiency furnaces and boilers?

13. MANUFACTURER IMPACT ANALYSIS

The policies outlined in the Department's "process rule" (61 Fed. Reg. 36974, July 15, 1996) called for substantial revisions to the analytical framework to be used in performing manufacturer impact analysis. The Department held a public workshop on March 11 and 12, 1997, to describe and obtain comment on a new generic methodology to be used in performing future manufacturing impact analyses of products covered under the NAECA. The Department intends to apply this methodology to other EPCA-related efficiency standards as well, tailoring the methodology for each rule on the basis of stakeholder comments.

13.1 SOURCES OF INFORMATION FOR THE MANUFACTURER IMPACT ANALYSIS

Prior analysis described earlier serves as the basis for much of the manufacturer impact analysis. Information includes financial parameters (Section 3.1), manufacturing costs (Section 6.0), shipments forecasts (Section 9.0), and price forecasts (Section 7.0). This information is supplemented with information gathered during interviews with manufacturers. The interview process has a key role in the manufacturer impact analyses, since it provides an opportunity for interested parties to privately express their views on important issues, allowing confidential or sensitive information to be considered in the rulemaking decision.

The Department or its contractors will conduct detailed interviews with as many manufacturers as is necessary to gain insight into the range of potential impacts of standards. During the interviews, the Department solicits information on the possible impacts of potential efficiency levels on manufacturing costs, equipment prices, sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information is valuable. Interviews will be scheduled well in advance in order to provide every opportunity for key individuals to be available for comment. Although a written response to the questionnaire is acceptable, an interactive interview process is preferred because it helps clarify responses and provides the opportunity for additional issues to be identified.

Interview participants will be requested to identify all confidential information provided in writing or orally. All information transmitted will be considered, as appropriate, in DOE's decision-making process. However, confidential information will not be made available in the public record. Participants will also be asked to identify all information they wish included in the public record but that they do not want to have associated with their interview. This information will be incorporated into the public record but reported without attribution.

DOE will collate the completed interview questionnaires and prepare a summary of the major issues and outcomes. The Department will seek comment on the outcome of the interview process.

13.2 INDUSTRY CASH FLOW ANALYSIS

The Industry Cash Flow Analysis relies primarily upon the GRIM. The Department uses the GRIM to analyze the financial impacts of more stringent energy efficiency standards on the industry that produces the products covered by the standard.

The GRIM analysis uses a number of factors -- annual expected revenues; manufacturer costs such as costs of sales, selling and general administration costs; taxes; and capital expenditures related to depreciation, new standards, and maintenance -- to arrive at a series of annual cash flows beginning from the announcement of the new standard and continuing for several years after implementation. The results are compared against baseline projections that involve no new standards. The financial impact of new standards is then the difference between the two sets of discounted annual cash flows. Other performance metrics such as return on invested capital are also available from the GRIM.

For discussion purposes, the Department will prepare a list of default financial values to be used in the GRIM industry analysis. These will be calculated by studying publicly available financial statements of furnace and boiler manufacturers, if available, or statements of companies in similar industries.

13.3 MANUFACTURER SUB-GROUP ANALYSIS

Using industry “average” cost values is not adequate for assessing differential impacts among sub-groups of manufacturers. Smaller manufacturers, niche players, or manufacturers exhibiting a cost structure that differs largely from the industry average could be more negatively impacted. Ideally, the Department would consider the impact on every firm individually. In highly concentrated industries this may be possible. In industries having numerous participants, the Department uses the results of the industry characterization to group manufacturers exhibiting similar characteristics.

What procedures should we follow when scheduling interviews and requesting information? Is there any value in grouping manufacturers into sub-groups? More generally, what would a well executed sub-group analysis entail?

13.4 COMPETITIVE IMPACTS ASSESSMENT

Legislation directs the Department to consider any lessening of competition that is likely to result from standards above the current minimum efficiency standards. It further directs the Attorney General to gauge the impacts, if any, of any lessening of competition. DOE will make a determined effort to gather and report firm-specific financial information and impacts. The competitive analysis will focus on assessing the impacts to smaller, yet significant, manufacturers. The assessment will be based on manufacturing cost data and on information collected from interviews with manufacturers. The manufacturer interviews will focus on gathering information that would help in assessing asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (proprietary technologies, etc.)

13.5 CUMULATIVE REGULATORY BURDEN

The Department will recognize and seek to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same equipment or companies.

The Department is aware that regulations that affect the manufacturers of residential air conditioners and heat pump, such as the increase in the efficiency standards for residential water heaters and residential unitary air conditioners and heat pumps, also affect this industry.

Are there any other regulations or pending regulations that the Department should consider?

14. UTILITY IMPACTS

To perform the Utility Impacts Analysis, which would include an analysis of the electric and gas utility industry, the Department is considering using the EIA's NEMS. NEMS is a large multi-sectoral partial equilibrium model of the U.S. energy sector that has been developed over several years by the EIA primarily for the purpose of preparing the *Annual Energy Outlook (AEO)*. NEMS produces a widely recognized baseline forecast for the United States through 2030 and is available in the public domain. Outputs of the utility analysis can parallel results that appear in the latest AEO, with some additions. Typical output includes forecasts of sales, price, and avoided capacity. The entire utility analysis can be conducted as a policy deviation from the latest AEO, and the assumptions in place there can serve as the basic set of assumptions applied.

Should we consider using alternative methods to NEMS for conducting the utility impacts analysis?

15. ENVIRONMENTAL ANALYSIS

The standards analysis tracks three types of energy-related emissions: sulfur dioxide (SO₂), nitrous oxides (NO_x) and carbon dioxide (CO₂). These emissions are calculated based on conversion factors developed by EIA for translating natural gas and oil savings into emission reductions.

To perform the Environmental Analysis, the Department will use EIA's NEMS. Outputs of the environmental analysis will mostly parallel results that appear in the latest AEO, with some additions. The entire environmental analysis can be conducted as a policy deviation from the latest AEO, and the assumptions in place there can be the basic set of assumptions applied. For example, the operating characteristics (energy conversion efficiency, emissions rates, etc.) of future electricity generating plants can be exactly those used in the latest AEO.

Carbon emissions are tracked in NEMS by a detailed carbon module which has broad coverage of all sectors and inclusion of interactive effects. NEMS also includes a module for SO₂ allowance trading and delivers a forecast of SO₂ allowance prices. It is important to note, however, that accurate simulation of SO₂ trading tends to imply that the physical emissions effects will be zero. This fact has caused confusion in the past, and, in prior energy efficiency standards analyses, a simple emission reduction has been reported with the caveat that emissions trading implies that this reduction is unlikely to be realized. However, there is an SO₂ benefit from conservation in the form of a lower allowance price, and if it is significant enough to be calculable by NEMS, this value can be reported. NEMS also includes an algorithm for estimating the NO_x emissions from power generation, but as for SO₂, this is somewhat inadequate because it does not estimate in-building emissions. Separate in-building NO_x and SO₂ emissions will be estimated based on simple emissions factors derived from general literature.

The results for the environmental analysis can be reported in the form of a complete NEMS run. In general, NEMS outputs become the tables of an AEO, and these should provide a good idea of the range of results available. NEMS output lists NO_x and carbon emissions and a resulting SO₂ trading price and SO₂ impact from oil-fired furnaces and boilers.

Are there any other environmental factors the Department should consider? If so, what additional analytical methods are appropriate for addressing them?

16. EMPLOYMENT IMPACTS

Both direct and indirect impacts on employment are possible from standards. Direct employment impacts would result if standards led to a change in the number of employees at the plants that produce the covered product, along with the affiliated distribution and service companies. The Department will estimate the direct employment impacts in the manufacturer sub-group analysis described in Section 13. In addition, the Department will estimate the combined direct and indirect (net national) impacts on employment for product manufacturers, relevant service industries, energy suppliers, and the economy in general. Indirect impacts may result both from expenditures shifting among goods (substitution effect), and from changing equipment and operating costs, which will lead to a change in overall expenditure levels (income effect). The Net National Employment Impacts analysis will capture both direct and indirect impacts by estimating the national job creation (or elimination) from possible standards, resulting from reallocation of the associated consumer expenditures for purchasing and operating appliances. The Department will examine and review alternative methods or models to assess employment impacts.

Do the above methods seem adequate for estimating both direct and indirect employment impacts? If not, what other methods or models should be used to assess employment impacts?